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Remarks

In view of the above amendments to the claims and the following discussion, the applicants submit that the claims now pending in the application are not anticipated under the provisions of 35 U. S. C. § 102, or obvious under the provisions of 35 U. S. C. § 103. Thus, the applicants believe that all of these claims are in allowable form.

OBJECTIONS

A. Specification

The Examiner objects to the abstract of the disclosure because it contains plural paragraphs. Applicants have amended the Abstract to be a single paragraph. In view of this amendment to the Abstract of the disclosure, the basis for the Examiners' objection thereto has been removed. Therefore, it is respectfully requested that the Examiner's objection to the specification be withdrawn.

B. Claims

1. Claims 1-8

Claims 1-8 are objected to for informalities. In particular, the Examiner indicates that in claim 1 the phrase "control means to control the ***power*** of the driving signal depending on the gain" is disclosed in the specification as "varying the ***amplitude*** of the driving signal supplied to the image sensor depending on the gain". Applicants have amended claim 1 to replace the term "power" with the term "amplitude".

In view of this amendment to claim 1, the basis for the Examiners' objection to claims 1-8 has been removed. Therefore, it is respectfully requested that the Examiner's objection to claims 1-8 be withdrawn.

2. Claims 1 and 9

Claims 1 and 9 are objected to for informalities. In particular, the Examiner indicates that in claims 1 and 9 the term "characterized" is misspelled. Applicants have amended claims 1 and 9 to delete the term "characterised" therefrom.

In view of these amendments to claims 1 and 9, the basis for the Examiners' objection to claims 1 and 9 has been removed. Therefore, it is respectfully requested that the Examiner's objection to claims 1 and 9 be withdrawn.

REJECTIONS

A. 35 U. S. C. § 102

1. Claims 1-6 and 9-10 are not anticipated by Kimura et al.

Claims 1-6 and 9-10 stand rejected under 35 U. S. C. § 102(b) as being anticipated by Kimura et al. (U. S. Patent 4,860,095 issued August 22, 1989). The applicants submit that these claims are not anticipated by this reference.

Claim 1 relates to controlling the maximum charge that can be generated in a CCD or CMOS sensor in dependence of the gain applied to the output signal. As is known to the person ordinarily skilled in the art, the amplitude of the control signals, notably the reset pulse, determines the maximum charge that can be accumulated in the photosensitive regions of a CCD or CMOS image sensor during exposure by light impinging on the sensor. The maximum charge accumulated in the photo sensitive regions of a CCD or CMOS image sensor,

however, determines the maximum level of the signal provided by the CCD image sensor. Therefore, by controlling the maximum charge which can be accumulated in the photo sensitive regions of a CCD or CMOS image sensor the maximum level of the signal provided by the CCD or CMOS image sensor can be controlled.

The invention recited in claim 1 uses this finding for avoiding adverse effects of overexposed pixels on neighbouring pixels which are not overexposed, which effects may occur when the gain is set relatively high. The example provided on page 1 of the specification, for example, assumes that the maximum charge handing capacity of an exemplary image sensor amounts to 400% of a nominal charge for full exposure. If an image captured has very bright regions and regions of low light intensity those very bright regions may accumulate charges four times higher than the nominal charge for full exposure. At the same time the regions of low light intensity may accumulate small charges corresponding to fractions of the nominal charge for full exposure. It may be desirable to amplify the signal generated from the small charges corresponding to the regions of low light intensity in order to obtain an image in which those regions are reproduced such that they can be viewed properly. However, since signal amplification is applied to signals coming from all pixels of the captured image, those signals corresponding to very bright regions are massively over-amplified. The exemplary figures provided in the example on page 1 of the specification shows a resulting signal corresponding to 1600% of a nominal charge for full exposure when 12 dB gain is applied to the signal. 1600%, however, correspond to a signal that is 16 times as high as a signal corresponding to a nominal charge for full exposure. A signal that is 16 times as high as a signal corresponding to nominal charge for full exposure generates unacceptable ringing and streaking, both inside the CCD image sensor during charge transfer and in the subsequent image transfer and processing. According to the invention the maximum charge that can be accumulated in a pixel of the CCD image sensor is reduced when the gain by which the output signal is

amplified is set high, thereby reducing adverse effects introduced during charge transfer within the image sensor and in the subsequent image transfer and processing. As a result regions of rather low light intensity may be viewed properly, while overexposed regions are still reproduced as overexposed regions. However, the lack of information in overexposed regions remains limited to those regions which were actually overexposed during image capture, without adversely affecting neighbouring pixels which did not suffer from overexposure during image capture.

Kimura et al. discloses modifying the phase and amplitude of drive signals to a CCD image sensor depending on the length of a cable between a driver and the CCD image sensor in an endoscope. In endoscopes, the CCD image sensor is located in an insertion section which is inserted into a cavity of a patient body under inspection, and a control section including a driver for controlling the CCD image sensor is located away from the insertion section. The CCD image sensor and the control section are connected by a cable, wherein the CCD image sensor is located at a distal end of the cable and the control section is located at a proximal end of the cable. As is generally known, the complex cable impedance attenuates signals and introduces frequency dependent phase lags due to frequency dependent signal propagation in the cable. In endoscopes, the length of the cable between the insertion section the control section can vary. As a consequence driving signals received at the distal end of a cable connecting the CCD image sensor and the driver may have amplitude and phase relationships differing from the amplitude and phase relationships of those signals originally applied to the proximal end of the cable, depending on the length of the cable. Further, the shape of pulses applied to the cable for driving the CCD image sensor may be distorted, resulting in pulse duty cycles at the CCD image sensor which are different from the pulse duty cycles originally applied to the proximal end of the cable. The variation in the phase relationship may lead to improper sampling of the signal output by the CCD image sensor, resulting in erroneous values (*see*, Kimura et al. at column 2, lines 25 to 47). In order to mitigate the

above-mentioned drawbacks Kimura et al. discloses determining the length of the cable between the driver and the CCD image sensor and controlling the amplitude and phase relationship of pulses applied to the proximal end of the cable depending on the cable length. In other words, the drive signal is adjusted in accordance with the length of the cable, or with respect to cable attenuation or cable loss (*see*, Kimura et al. at column 9, lines 29 to 44). By doing so it is ensured that the CCD image sensor always receives drive signals corresponding to standard or nominal levels (*see*, Kimura et al. at column 9, lines 48 to 49). The purpose of the prior art disclosed by Kimura et al. is maintaining optimum conditions of driving the CCD image sensor irrespective of the cable length (*see*, Kimura et al. column 12, lines 52 to 53). Kimura et al. further discloses controlling the gain of an amplifier for amplifying the video signal output by the CCD image sensor depending on the cable length.

In contrast to the invention recited in claim 1, Kimura et al. is adapted to always maintain the nominal output signal by always maintaining a nominal amplitude of the driving signals at the CCD image sensor rather than controlling the maximum output signal amplitude or value that can be output by the image sensor for avoiding adverse effects of overexposed pixels on their neighbouring pixels. In order to achieve the objective, Kimura et al. determines the length of the cable connecting a driver section and the input of the CCD image sensor rather than limiting the maximum output signal which can be generated in the CCD image sensor. In fact, since Kimura et al.'s object is to provide a proper image signal even in the presence of high attenuation on a cable limiting the maximum output signal which can be generated in the CCD image sensor teaches away from the solution found in the invention as claimed in claim 1.

In view of the discussion above and since Kimura et al. fails to teach controlling the maximum output signal amplitude that can be output by the image sensor, the invention as claimed in claim 1 is patentable Kimura et al.

Claims 2 to 7 and 8 depend directly, or indirectly from claim 1. Claims 9-10 recite similar subject matter as claim 1. For the same reasons stated above for claim 1 claims 2-7 and 9-10 are also patentable over Kimura et al.

B. 35 U. S. C. § 103

1. Claim 7 is not unpatentable over Kimura et al. in view of Topper

Claim 7 stands rejected under 35 U. S. C. § 103(a) as being unpatentable over Kimura et al. (U. S. Patent 4,860,095 issued August 22, 1989) in view of Topper (Us Patent 4,683,498 issued July 28, 1987). The applicants submit that this claim is not rendered obvious by the combination of these references.

Claim 7 relates to controlling the maximum charge that can be generated in a CCD or CMOS sensor in dependence of the gain applied to the output signal. As is known to the person ordinarily skilled in the art, the amplitude of the control signals, notably the reset pulse, determines the maximum charge that can be accumulated in the photosensitive regions of a CCD or CMOS image sensor during exposure by light impinging on the sensor. The maximum charge accumulated in the photo sensitive regions of a CCD or CMOS image sensor, however, determines the maximum level of the signal provided by the CCD image sensor. Therefore, by controlling the maximum charge which can be accumulated in the photo sensitive regions of a CCD or CMOS image sensor the maximum level of the signal provided by the CCD or CMOS image sensor can be controlled.

The invention recited in claim 7 uses this finding for avoiding adverse effects of overexposed pixels on neighbouring pixels which are not overexposed, which effects may occur when the gain is set relatively high. The example provided on page 1 of the specification, for example, assumes that the maximum charge handing capacity of an exemplary image sensor amounts to 400% of a nominal charge for full exposure. If an image captured has very bright regions

and regions of low light intensity those very bright regions may accumulate charges four times higher than the nominal charge for full exposure. At the same time the regions of low light intensity may accumulate small charges corresponding to fractions of the nominal charge for full exposure. It may be desirable to amplify the signal generated from the small charges corresponding to the regions of low light intensity in order to obtain an image in which those regions are reproduced such that they can be viewed properly. However, since signal amplification is applied to signals coming from all pixels of the captured image, those signals corresponding to very bright regions are massively over-amplified. The exemplary figures provided in the example on page 1 of the specification shows a resulting signal corresponding to 1600% of a nominal charge for full exposure when 12 dB gain is applied to the signal. 1600%, however, correspond to a signal that is 16 times as high as a signal corresponding to a nominal charge for full exposure. A signal that is 16 times as high as a signal corresponding to nominal charge for full exposure generates unacceptable ringing and streaking, both inside the CCD image sensor during charge transfer and in the subsequent image transfer and processing. According to the invention the maximum charge that can be accumulated in a pixel of the CCD image sensor is reduced when the gain by which the output signal is amplified is set high, thereby reducing adverse effects introduced during charge transfer within the image sensor and in the subsequent image transfer and processing. As a result regions of rather low light intensity may be viewed properly, while overexposed regions are still reproduced as overexposed regions. However, the lack of information in overexposed regions remains limited to those regions which were actually overexposed during image capture, without adversely affecting neighbouring pixels which did not suffer from overexposure during image capture.

Kimura et al. discloses modifying the phase and amplitude of drive signals to a CCD image sensor depending on the length of a cable between a driver and the CCD image sensor in an endoscope. In endoscopes, the CCD image sensor

is located in an insertion section which is inserted into a cavity of a patient body under inspection, and a control section including a driver for controlling the CCD image sensor is located away from the insertion section. The CCD image sensor and the control section are connected by a cable, wherein the CCD image sensor is located at a distal end of the cable and the control section is located at a proximal end of the cable. As is generally known, the complex cable impedance attenuates signals and introduces frequency dependent phase lags due to frequency dependent signal propagation in the cable. In endoscopes, the length of the cable between the insertion section the control section can vary. As a consequence driving signals received at the distal end of a cable connecting the CCD image sensor and the driver may have amplitude and phase relationships differing from the amplitude and phase relationships of those signals originally applied to the proximal end of the cable, depending on the length of the cable. Further, the shape of pulses applied to the cable for driving the CCD image sensor may be distorted, resulting in pulse duty cycles at the CCD image sensor which are different from the pulse duty cycles originally applied to the proximal end of the cable. The variation in the phase relationship may lead to improper sampling of the signal output by the CCD image sensor, resulting in erroneous values (*see*, Kimura et al. at column 2, lines 25 to 47). In order to mitigate the above-mentioned drawbacks Kimura et al. discloses determining the length of the cable between the driver and the CCD image sensor and controlling the amplitude and phase relationship of pulses applied to the proximal end of the cable depending on the cable length. In other words, the drive signal is adjusted in accordance with the length of the cable, or with respect to cable attenuation or cable loss (*see*, Kimura et al. at column 9, lines 29 to 44). By doing so it is ensured that the CCD image sensor always receives drive signals corresponding to standard or nominal levels (*see*, Kimura et al. at column 9, lines 48 to 49). The purpose of the prior art disclosed by Kimura et al. is maintaining optimum conditions of driving the CCD image sensor irrespective of the cable length (*see*, Kimura et al. column 12, lines 52 to 53). Kimura et al. further discloses controlling

the gain of an amplifier for amplifying the video signal output by the CCD image sensor depending on the cable length.

In contrast to the invention recited in claim 7, Kimura et al. is adapted to always maintain the nominal output signal by always maintaining a nominal amplitude of the driving signals at the CCD image sensor rather than controlling the maximum output signal amplitude or value that can be output by the image sensor for avoiding adverse effects of overexposed pixels on their neighbouring pixels. In order to achieve the objective, Kimura et al. determines the length of the cable connecting a driver section and the input of the CCD image sensor rather than limiting the maximum output signal which can be generated in the CCD image sensor. In fact, since Kimura et al.'s object is to provide a proper image signal even in the presence of high attenuation on a cable limiting the maximum output signal which can be generated in the CCD image sensor teaches away from the solution found in the invention as claimed in claim 7.

Topper describes an image pick-up device including three image sensors 14, 16, 18 (*see*, Topper at FIG. 1 and column 3, lines 13-28).

Topper does not describe or suggest an arrangement to control the maximum charge which can be accumulated in the photo sensitive regions of a CCD or CMOS image sensor in order to control the maximum level of the signal provided by the CCD or CMOS image sensor.

In view of the discussion above and since Kimura et al. in view of Topper fails to teach controlling the maximum output signal amplitude that can be output by the image sensor, the invention as claimed in claim 7 is patentable over the combination of these references

CONCLUSION

Thus, the applicants submit that none of the claims presently in the application are anticipated under the provisions of 35 U. S. C. § 102, or obvious under the provisions of 35 U. S. C. § 103. Consequently, the applicants believe

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that all of the claims are presently in condition for allowance. Accordingly, both reconsideration of this application and its swift passage to issue are earnestly solicited.

If, however, the Examiner believes that there are any unresolved issues requiring adverse final action in any of the claims now pending in the application, it is requested that the Examiner telephone Ms. Patricia A. Verlangieri, at (609) 734-6867, so that appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Respectfully submitted,

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